# Standard Operating Procedure

# for

# $PM_{2.5}$ Organic Sampling Using PUF Cartridges during Intensive Operating Periods in CRPAQS

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# 1.0 DESCRIPTION OF SAMPLING APPARATUS

## 1.1 General Description

The Fine Particulate/Semi Volatile Organic Compound (FPSVOC) sampling system is DRI's sequential sampler (see Figure 1) for collecting particulate and semi-volatile gaseous polyaromatic hydrocarbons and other organic compounds. This is a multi-event sampler, allowing unattended collection of up to four samples. The air sample is drawn through a cyclone separator with a cut-off diameter of 2.5 µm, operating at 113 lpm. Downstream of the cyclone, a ½-inch copper manifold leads to four momentum diffuser chambers. Each chamber is followed by a filter/PUF/XAD/PUF cartridge holder and is connected to a vacuum pump through a needle valve and solenoid valve. When one of the solenoid valves is opened and three others are closed, the air stream enters only this one chamber which is connected to the pump. The sampling time is controlled by a four-channel Grasslin timer, which automatically opens and closes the solenoid valves at the appropriate times. The sampling time for each channel is recorded by an independent elapsed time meter. The flow is set using a calibrated rotameter on the inlet side of the copper sampling line, and is maintained at a constant 113 lpm during sampling by a mass flow controller. The sampler is also equipped with a magnehelic gauge to monitor the vacuum pressure both before and after the sampling cartridge. The pressure upstream from the sampling cartridge serves as a surrogate for sample flow, and the difference in the gauge readings indicates the extent of sample loading. The sampler runs on 120 V AC and draws 15 amps to start and 9 amps during regular operation. The sampler is 26 inches wide, 20 inches deep and 48 inches high.

## 1.2 Sampling Manifold Assembly (blue fiberglass case)

The sampling manifold assembly consists of the inlet manifold, four diffuser chambers, four PUF sampling heads, and a magnehelic gauge. The sampling module is commercially available and consists of a glass sampling cartridge and an air-tight metal cartridge filter holder (see Figure 2). The adsorbent (XAD-2 or PUF) is retained in the glass sampling cartridge. The entire assembly is housed in a blue metal carrying case. The case also contains a Dwyer RMC-104 rotameter (Serial No. PUF-3A), a 2.5 µm cyclone sampling head assembly, 25 feet of copper tubing, and fastening screws for attaching the inlet manifold to the sampler control box. The rotameter serves as the flow rate transfer standard.

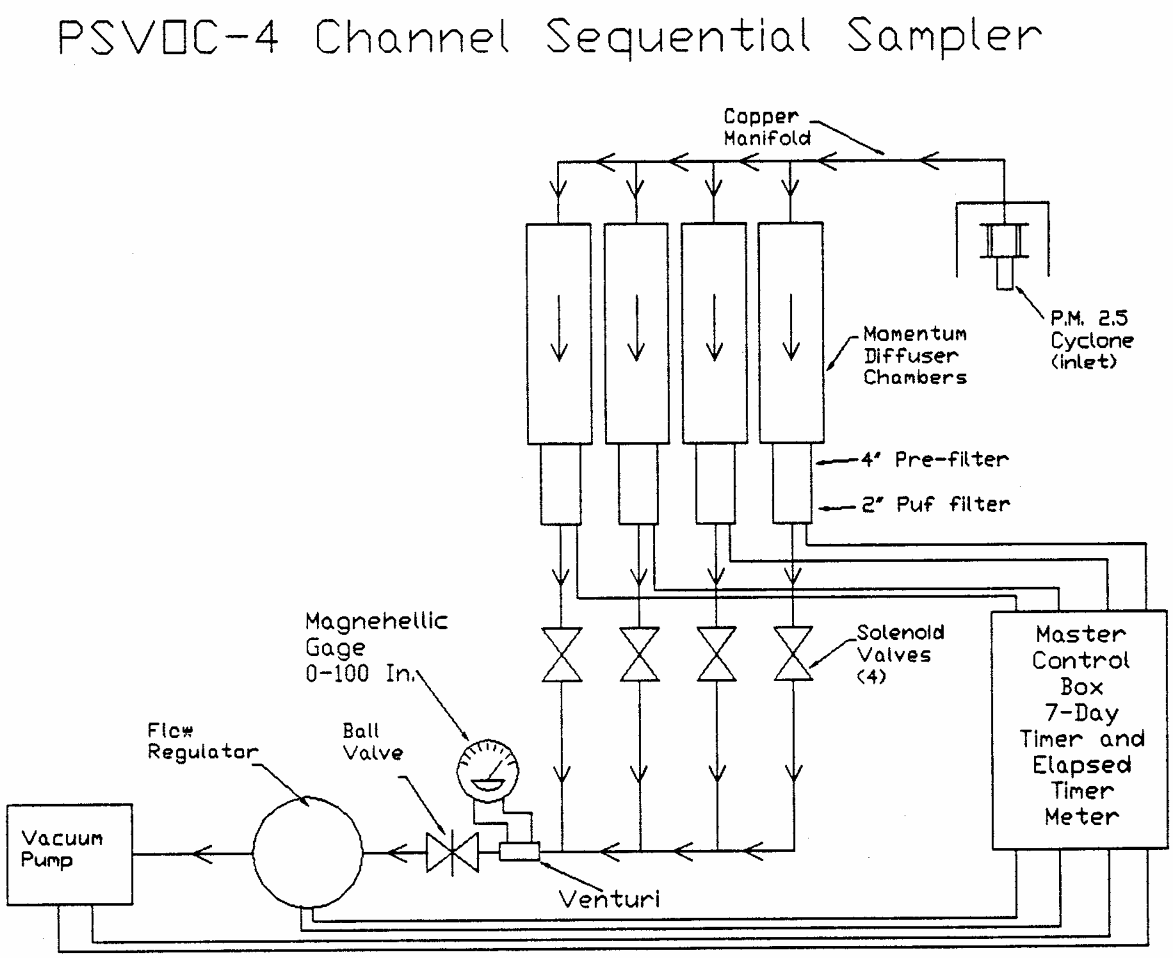


Figure 1. DRI SVOC 4 Channel Sequential Sampler.

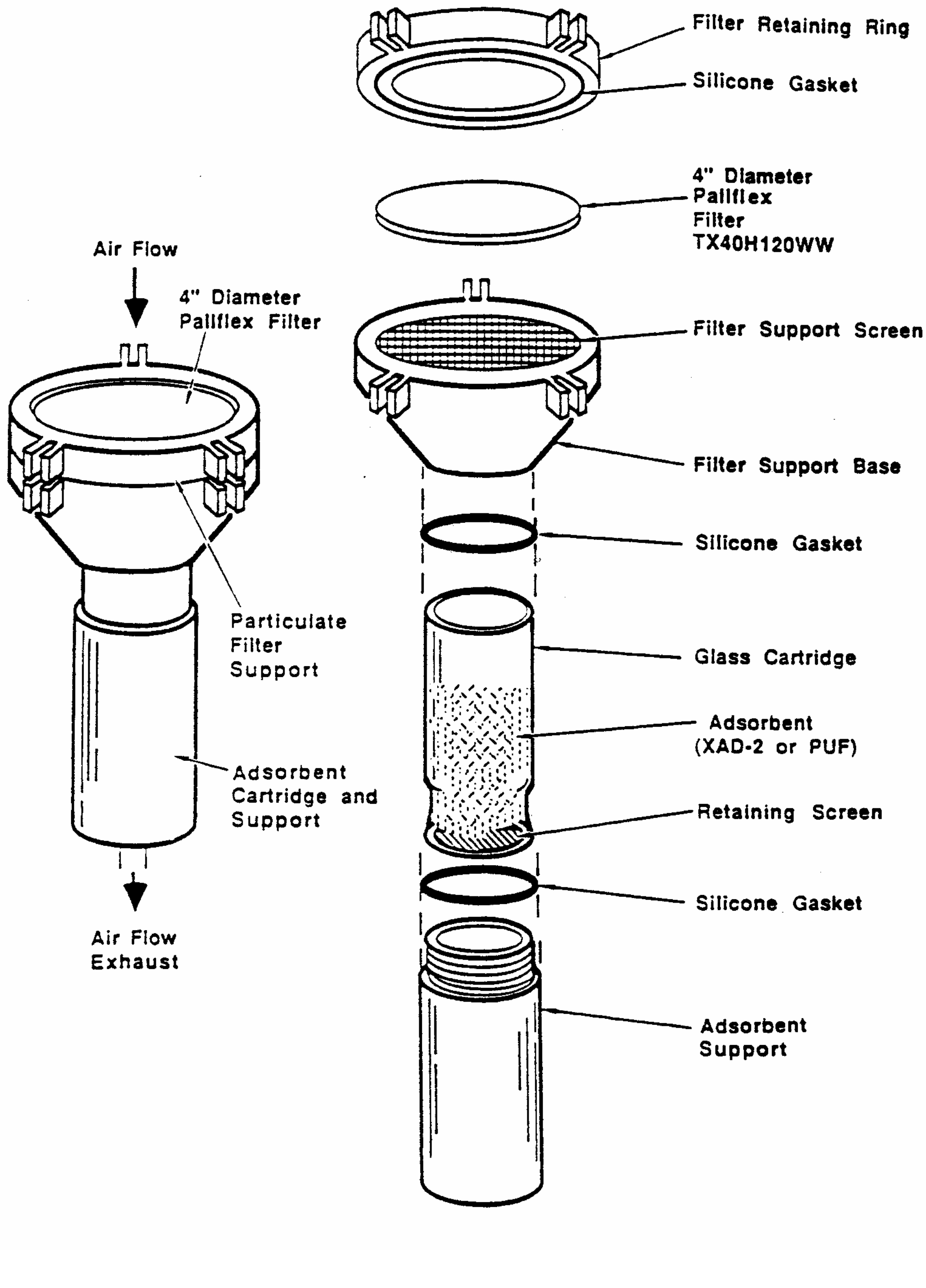


Figure 2. PUF Sampling Head.

### 1.3 Sampler Control Unit (black fiberglass case)

The sampler control unit consists of a Series 988 GAST vacuum pump model 1022-V103-G272X with a Waters exhaust filter, four resettable elapsed time meters, a four-channel Grasslin programmable timer, four quick disconnects for attaching the sampling heads to the vacuum manifold, and a 110 V power cord.

## 2.0 SAMPLER ASSEMBLY AND TAKE-DOWN

- Remove the top of the case containing the pump, flow control and timer, and remove foam packing material.

- Open the case containing the sampling manifold assembly, and remove the manifold and the Phillips head ¼ / 20 bolts that are contained in a plastic bag inside the case.

- Place the sampling manifold assembly on the attachment brackets of the sampler control unit, line up the matching holes, and fasten bolts. The magnehelic gauge should be facing the front of the sampler control unit.

- Attach the magnehelic tube to the stainless steel three-way valve located on the right side of the sampling manifold assembly, and attach one side of the valve to the ¼-inch copper tubing to the right of the channel four elapsed time meter and the other side to the tap on the sampling manifold.

- Attach the four quick disconnects to the PUF sampling heads. The FPSVOC sampler will be shipped with filters and PUF cartridges in the four PUF heads which are to be used for testing and calibration. These will be replaced with sampling cartridges during actual sampling.

- Attach a ½-inch OD copper sampling line to either end of the sampling inlet manifold, whichever is most convenient, by removing the brass cap. Check the brass cap on the other end to ensure that it is secure.

- Run copper tubing to sample inlet location (not to exceed 25 feet), and attach the other end to the $PM_{2.5}$ cyclone assembly. The sampling line should be as straight as possible.

- During take-down, replace all components in their proper case and secure loose items with the packing material that is provided.

## 3.0 CALIBRATION OF SAMPLING SYSTEM

Each sampler is to be calibrated: 1) when new; 2) after major repairs or maintenance; 3) whenever any audit point deviates from the calibration curve by more than 7%; 4) when a different sample collection medium, other than that which the sampler was originally calibrated to, will be used for sampling; or 5) at the frequency specified in the user Standard Operating Procedure (SOP).

### 3.1 Calibration of Flow Rate Transfer Standard (Rotameter)

The Flow Rate Transfer Standard (rotameter) is used for calibration of the modified high volume air sampler. This flow rate transfer standard must be certified in the laboratory against a positive displacement rootsmeter. Recertification of the rotameter is performed once per year by the DRI Air Quality Standards Laboratory, according to appropriate SOP.

### 3.2 Calibration of the FPSVOC Sampling System Utilizing Calibrated Rotameter

The 6 - point calibration of the FPSVOC sampler is performed in the DRI laboratory, prior to sending the sampler to the field. The calibration procedure is described below.

3.2.1 Prior to initial multi-point calibration, place a "dummy" adsorbent cartridge and filter in the sampling head and activate the sampling motor. Open the flow control valve fully opened and adjust the voltage variator so that a sample flow rate corresponding to 110% of the desired flow rate (typically 0.20 - 0.28 $m^3$/min) is indicated on the magnehelic gauge (based on the previously obtained multi-point calibration curve). Allow the motor to warm up for 10 minutes and then adjust the flow control valve to achieve the desired flow rate. Then turn the sampler off. The ambient temperature and barometric pressure should be recorded on the Field Calibration Data Sheet.

3.2.2 Place the rotameter on the inlet end of the copper sampling line, replacing the cyclone assembly. Set flow to a reading of 245 SCFH on the rotameter by adjusting the flow setting on the needle valve for this channel.

3.2.3 Adjust the needle valve reading for temperature and pressure using the following equation:

$$X = \sqrt{\Delta H \frac{P_a}{P_{std}} \frac{T_{std}}{T_a}}$$

where: $X$ = adjusted manometer reading to standard temperature and pressure (in. water)

$\Delta H$ = observed manometer reading (in. water)

$P_a$ = current barometric pressure (mm Hg)

$P_{std}$ = 760 mm Hg

$T_a$ = current temperature (°K), (°K = °C + 273)

$T_{std}$ = standard temperature (298 °K)

3.2.4 Calculate the standard flow rate for each corrected manometer reading by the following equation:

$$Q_{std} = \frac{X - b}{M}$$

where: $Q_{std}$ = standard flow rate ($m^3$/min)

$M$ = slope of flow rate transfer standard calibration curve

$X$ = corrected manometer reading from the equation in Section 3.2.3 (in. water)

$b$ = intercept of flow rate transfer standard calibration curve

3.2.5 Adjust the magnehelic gauge readings to standard temperature and pressure using the following equation:

$$M_{std} = \sqrt{\frac{(M)(P_a)}{P_{std}} \frac{T_{std}}{T_a}}$$

where: $M_{std}$ = adjusted magnehelic reading to standard temperature and pressure (inches of water)

$M$ = observed magnehelic reading (inches of water)

$P_a$ = ambient atmospheric pressure (mm Hg)

$P_{std}$ = standard pressure (760 mm Hg)

$T_a$ = ambient temperature (°K), (°K = °C + 273)

$T_{std}$ = standard temperature (298 °K)

3.2.6 Plot each $M_{std}$ value (y-axis) versus its associated $Q_{std}$ standard (x-axis) on arithmetic graph paper. Draw a line of best fit between the individual plotted points. This is the calibration curve for the Venturi. Retain with sampler.

3.2.7 Record the corresponding $Q_{std}$ for each $M_{std}$ under $Q_{std}$ column on Field Calibration Data Sheet.

**3.3 Single-point Audit of the High-Volume Sampling System Utilizing Calibrated Flow Rate Transfer Standard**

3.3.1 A single point flow audit check is performed before and after each sampling period utilizing the Calibration Flow Rate Transfer Standard (rotameter).

3.3.2 Prior to single point audit, place "dummy" adsorbent cartridges and filters in all sampling heads, if not present there (the sampler is shipped with “dummy” cartridges and filters installed in the heads). Connect the rotameter to the sampling inlet and make sure the magnehelic gauge is connected. Activate the sampling motor by turning on the main power switch and pushing on the main fuse, located on the flow controller box. Allow the motor to warm up for approximately 5 minutes. Activate the first channel by pushing on the “on-off” button on the appropriate channel of the Grasslin timer. Record the ambient temperature and barometric pressure on a Field Data Sheet (Figure 3).

3.3.3 The flow is controlled by the needle valve, located on each channel before the solenoid valve. To change the flow, turn the knob on the valve. Wait 2-3 minutes for the flow to stabilize. Read the flow on the rotameter and record it on the Field Data Sheet.

3.3.4 To check the flow on the next channel, switch the first "on-off" button on the Grasslin timer off and switch the next one on. The active channel is indicated by the orange light located on the front panel. Wait until flow stabilizes and record it on the Field Data Sheet.

3.3.5 Switch off the pump and remove Flow Rate Transfer Standard and dummy adsorbent cartridge and filter assembly.

**NOTE: Be sure that the pump is switched off before disconnecting any hoses or removing filters.**

## 4.0 SAMPLE COLLECTION

4.1 After the sampling system has been assembled and flow checked as described in Section 3.0, it can be used to collect air samples.

4.2 The sampler should be located in an unobstructed area, at least 2 m from any obstacle to air flow. The exhaust hose should be stretched out in the downwind direction to prevent recycling of air into the sample head.

4.3 Detach the lower chamber of the sampling module. While wearing disposable, clean lint-free nylon or powder-free surgical gloves, remove a clean glass cartridge/sorbent from its container and unwrap its aluminum foil covering. The foil should be replaced after the sample has been collected.

4.4 Insert the cartridge into the lower chamber and tightly reattach it to the module.

4.5 Using clean Teflon®- tipped forceps, carefully place a clean fiber filter atop the filter holder and secure it in place by clamping the filter holder ring over the filter using the three screw clamps. Insure that all module connections are tightly assembled. [Note: Failure to do so could result in air flow leaks which could affect sample representativeness]. Ideally, sample module loading and unloading should be conducted in a controlled environment or at least a centralized sample processing area so that the sample handling variables can be minimized.

4.6 Repeat this procedure for all remaining channels.

4.8 Turn the sampler on, as described in Section 3.3 above, wait 2-3 minutes for the flow to stabilize and record the magnehelic gauge reading (both position) on the Field Data Sheet. Repeat this procedure for all channels.

4.9 Turn the sampler off and check the programs on the Grasslin timer, as described in the Grasslin manual (included with the sampler). The short description of the programs used for this project is included in the Section 6.0, below.

4.10 Ambient temperature, barometric pressure, elapsed time meter setting, sampler serial number, filter number, and adsorbent sample number are recorded on the Field Data Sheet (see Figure 3) at the beginning and end of the sampling period.

4.11 At the end of the desired sampling period, the power is turned off automatically. Carefully remove the sampling heads containing the filter and adsorbent cartridge to a clean area.

4.12 While wearing disposable lint-free nylon or surgical gloves, remove the sorbent cartridge from the lower module chamber and lay it on the retained aluminum foil in which the sample was originally wrapped.

4.13 Carefully remove the glass fiber filter from the upper chamber using clean Teflon®-tipped forceps.

4.14 Fold the filter in half twice (sample side inward) and place it in the glass cartridge atop the sorbent.

4.15 Wrap the combined samples in aluminum foil and place them in their original glass sample container. A sample label should be completed and affixed to the sample container. Chain-of-custody should be maintained for all samples.

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**PUF SAMPLER**

Sampler I.D.: ____________ Sample Date: ____________

Sample Location: (Site)____________________________

Sample Time: Start: ____________ Stop: ____________

Elapsed Timer: Start: ____________ ____________
(Hours) (Minutes)

End: ____________ ____________
(Hours) (Minutes)

PUF Cartridge #: ________________________
(Site Name - Date of Sample - Lot Numbers)

4" Inlet Filter #: ________________________
(Site Name - Date of Sample - Lot Numbers)

Flow Rate: Before: ________ After: ________

Flow Rate (Rotameter): Before: ________ After:________

Flow Rate (Magnehelic, up): Before: ________ After:________

Flow Rate (Magnehelic, down): Before: ________ After:________

Ambient temp of sample day: HIGH _____ LOW: _____

Ambient pressure of sample day: HIGH _____ LOW: _____

Comments: ________________________________________

________________________________________

________________________________________

________________________________________

Operators: Start: ________ Stop: ________

Figure 3. Field Data Sheet

4.16 The glass containers should be stored in ice and protected from light to prevent possible photo-decomposition of collected analytes. If the time span between sample collection and laboratory analysis is to exceed 24 hours, the sample must be kept refrigerated.

4.17 At least one field filter/adsorbent blank will be returned to the laboratory with each group of samples. A field blank is treated exactly as a sample except that no air is drawn through the filter/adsorbent cartridge assembly.

4.18 Samples are stored at 0 °C in an ice chest until they are received at the analytical laboratory, after which they are refrigerated at 4 °C.

## 5.0 SAMPLE SHIPMENT AND HANDLING

5.1 The samples (filter and adsorbent pairs) are shipped to the laboratory in a glass container in an ice chest.

5.2 The samples are logged in the laboratory logbook according to sample location, filter and adsorbent cartridge number identification and total air volume sampled (uncorrected).

5.3 If the time span between sample registration and analysis is greater than 24 hours, then the samples must be kept refrigerated. Minimize exposure of samples to fluorescent light. All samples should be extracted within one week after sampling.

## 6.0 Grasslin Timer Program

6.1 Set the clock to local time.

6.2 Day 1 = Monday

6.3 Program

| Set Time | CH On/Off | CH On/Off | Days of Week |
|---|---|---|---|
| 0600 AM | 1 On | | 1 - 3 - 5 - 7 |
| 1200 PM | 1 Off | 2 On | 1 - 2 - 3 - 4 - 5 - 6 - 7 |
| 0600 PM | 2 Off | 3 On | 1 - 2 - 3 - 4 - 5 - 6 - 7 |
| 0600 AM | 3 Off | | 1 - 2 - 3 - 4 - 5 - 6 - 7 |
| 0600 AM | 4 On | | 2 - 4 - 6 |
| 1200 PM | 4 Off | | 2 - 4 - 6 |

6.4 For programs to work, all channels must be in "unlock" position. This is shown in the LCD display. There should be a clock face by all channels displayed for the program to work. To change these displays, push the top right-hand four buttons marked with a "finger" (☜) symbol.